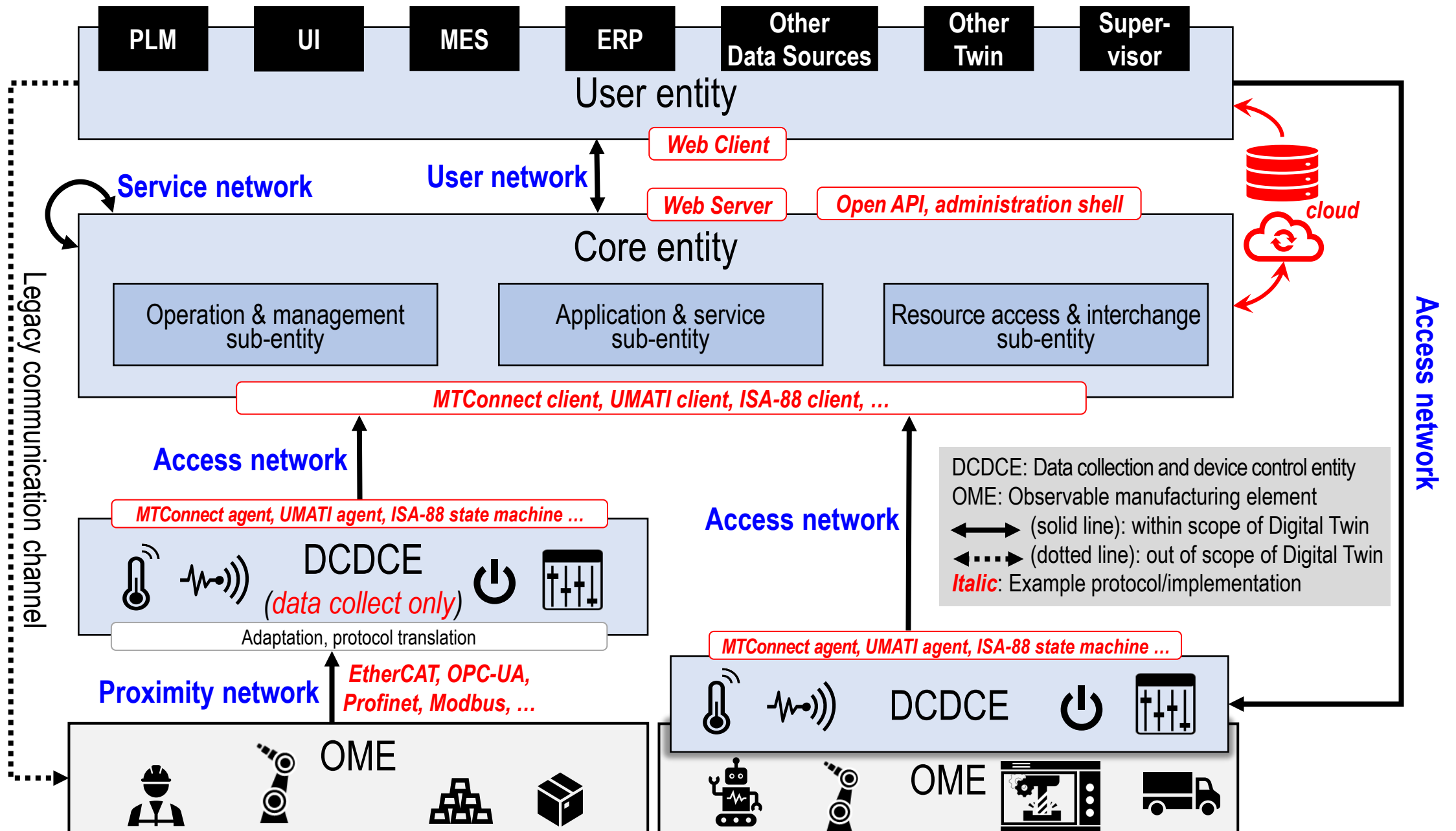


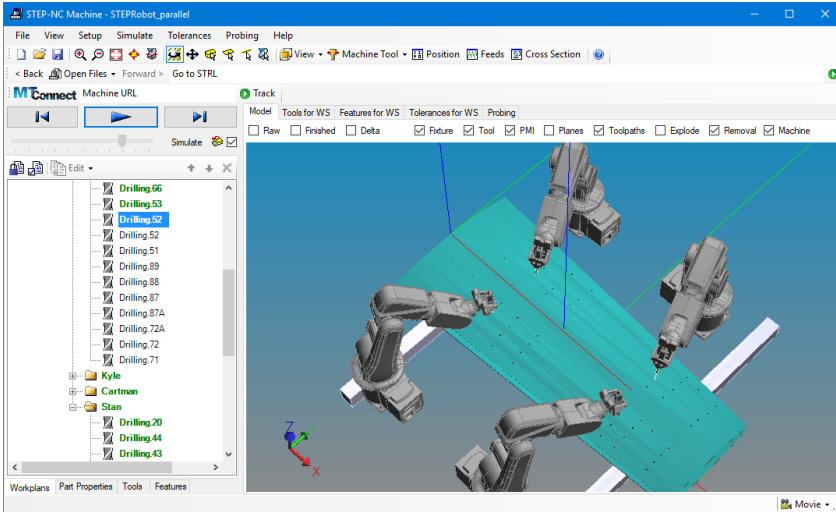
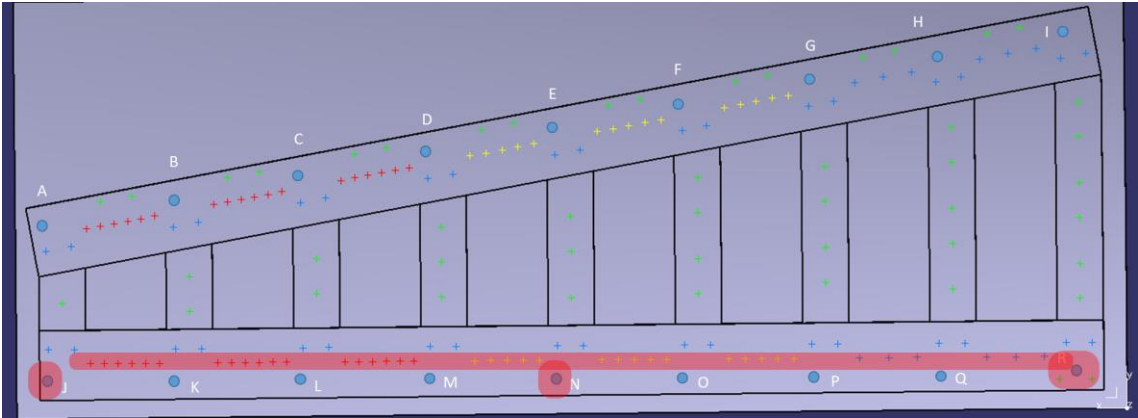
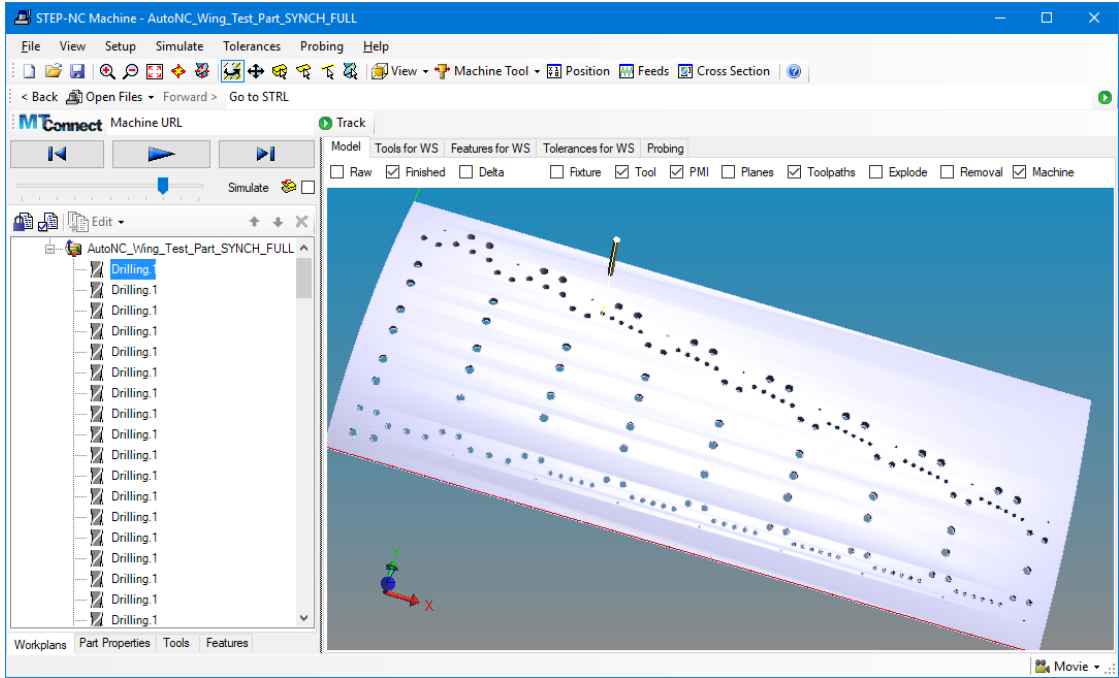
ISO 23247 Digital Twin Use case Testing

Results of July 28 Conference call

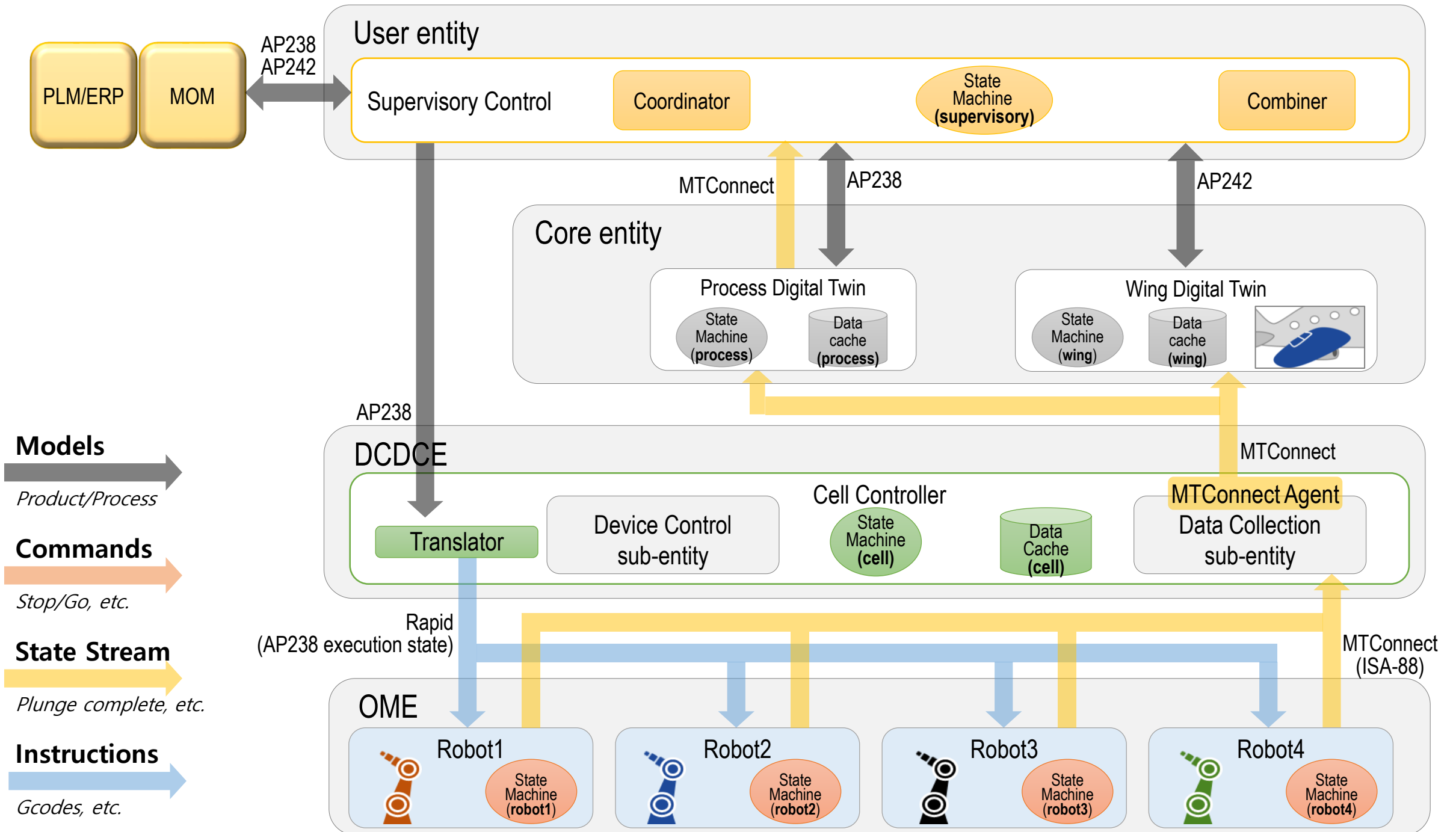
ISO 23247-4 Figure A.1



Use Case 1 – flexible schedule for robot drill & fill

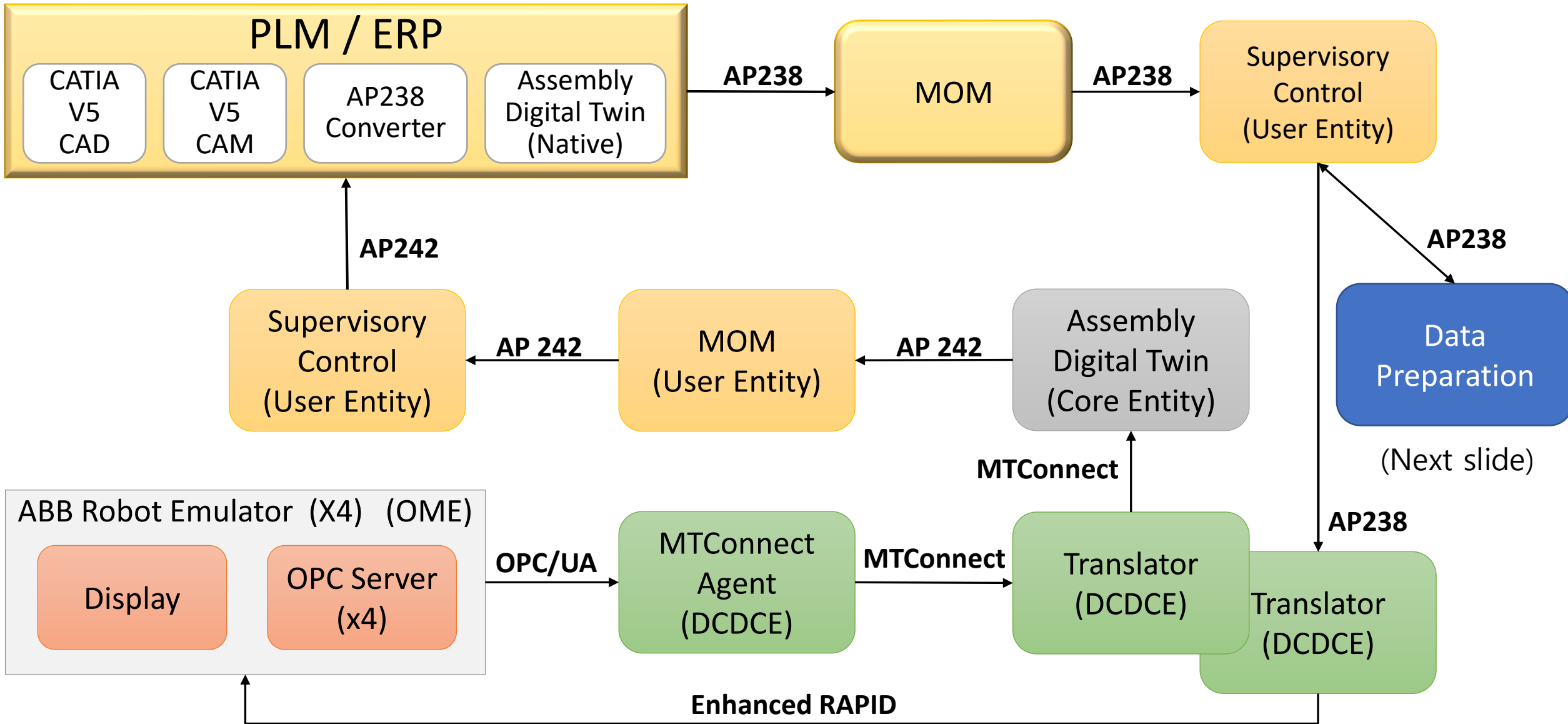


On-shoring can increase by 50%

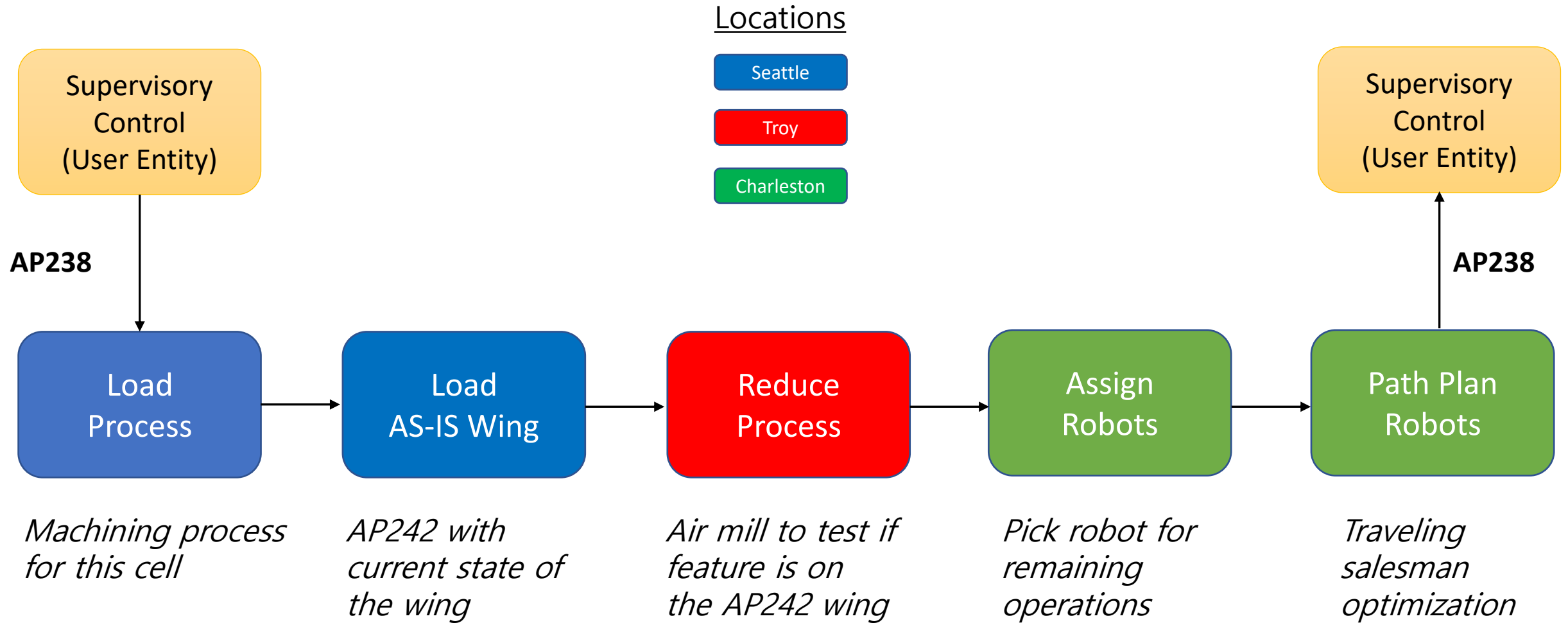


- Models** *Product/Process*
- Commands** *Stop/Go, etc.*
- State Stream** *Plunge complete, etc.*
- Instructions** *Gcodes, etc.*

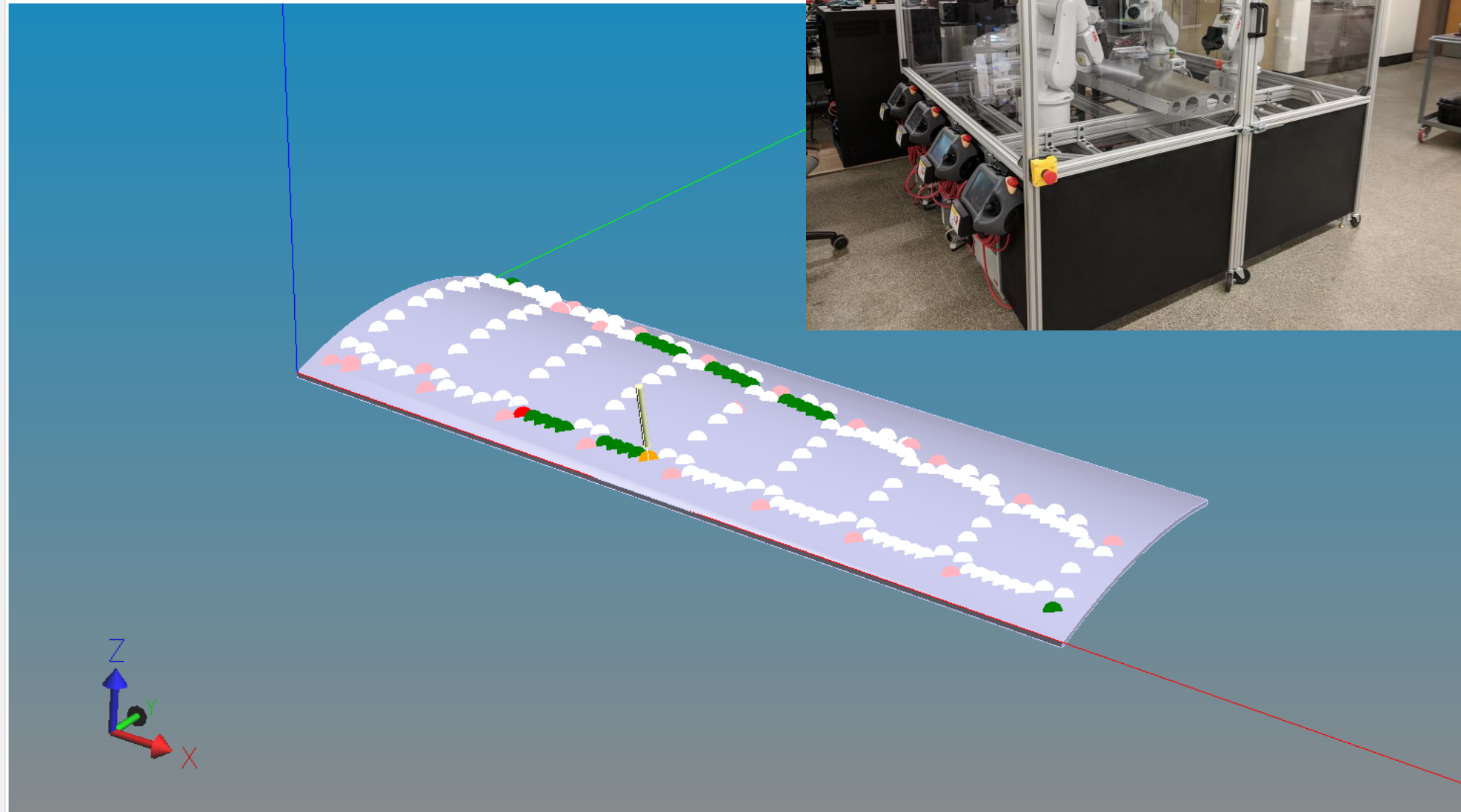
Assembly/Process Flow



Data Preparation



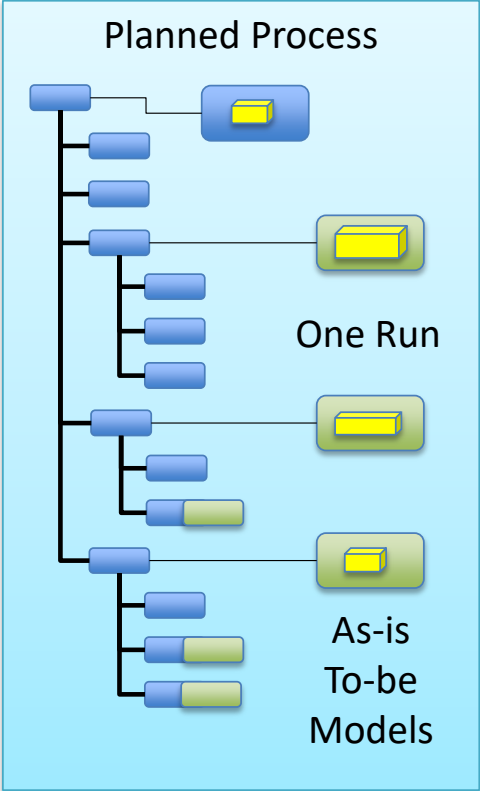
- Hole.1 (ROUND_HOLE)
- Hole.2 (ROUND_HOLE)
- Hole.3 (ROUND_HOLE)
- Hole.4 (ROUND_HOLE)
- Hole.5 (ROUND_HOLE)
- Hole.6 (ROUND_HOLE)**
 - Depth = 0.39 in
 - Diameter = 0.19 in
 - Position = (11.354, 1.149, 0.34) in
 - Bottom type = CONICAL_HOLE_BOTTOM
 - Tools
 - Tool - T6, D=0.19, L=1.96850393700787
 - Workingsteps
 - Drilling.6
 - Entity = 17463 Started = 2020-07-21T09:16:29.701-04:00
 - Ended =
 - Elapsed time =
- Hole.7 (ROUND_HOLE)
- Hole.8 (ROUND_HOLE)
- Hole.9 (ROUND_HOLE)
- Hole.10 (ROUND_HOLE)
- Hole.11 (ROUND_HOLE)
- Hole.12 (ROUND_HOLE)
- Hole.13 (ROUND_HOLE)
- Hole.14 (ROUND_HOLE)
 - Depth = 0.387 in
 - Diameter = 0.19 in
 - Position = (7.554, 1.139, 0.372) in
 - Bottom type = CONICAL_HOLE_BOTTOM
 - Tools
 - Tool - T6, D=0.19, L=1.96850393700787
 - Workingsteps
 - Drilling.14
 - Entity = 17391 Started = 2020-07-21T09:16:01.341-04:00
 - Ended = 2020-07-21T09:16:25.616-04:00
 - Elapsed = 24 seconds, 275 milliseconds
- Hole.15 (ROUND_HOLE)
- Hole.16 (ROUND_HOLE)
- Hole.17 (ROUND_HOLE)
- Hole.18 (ROUND_HOLE)



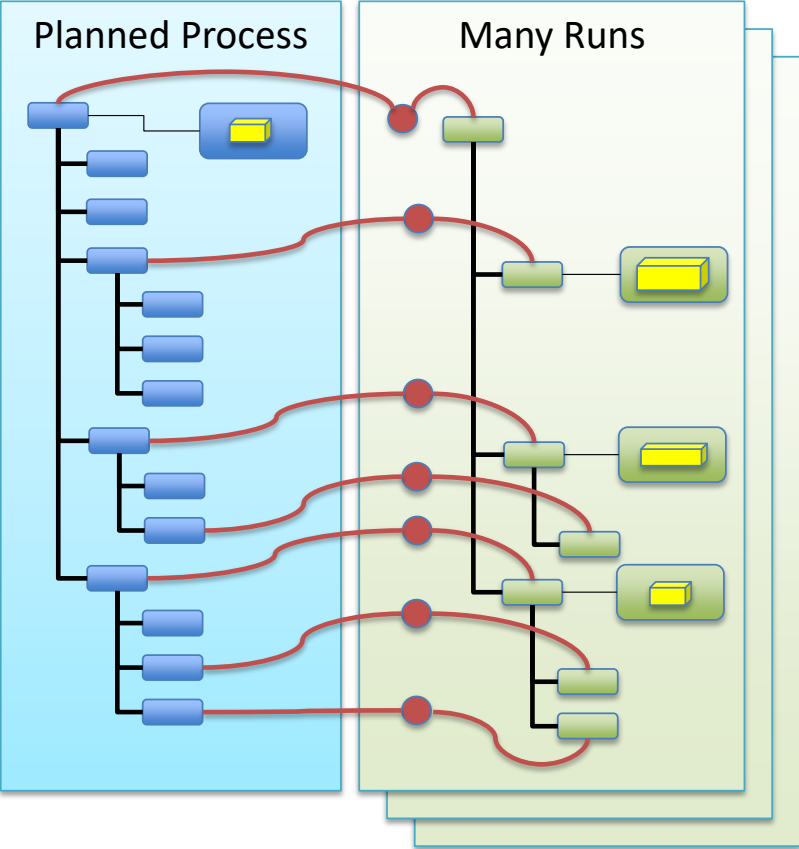
White (ready) Green (complete) Orange (in process) Red (error) Pink (missing data)

Digital Twin process model

<https://stepmfg.github.io/ap238e2/data/clause5.htm#fig-twinmodel>



Model process state using new attributes



Link runs using Part 21 Edition 3

```

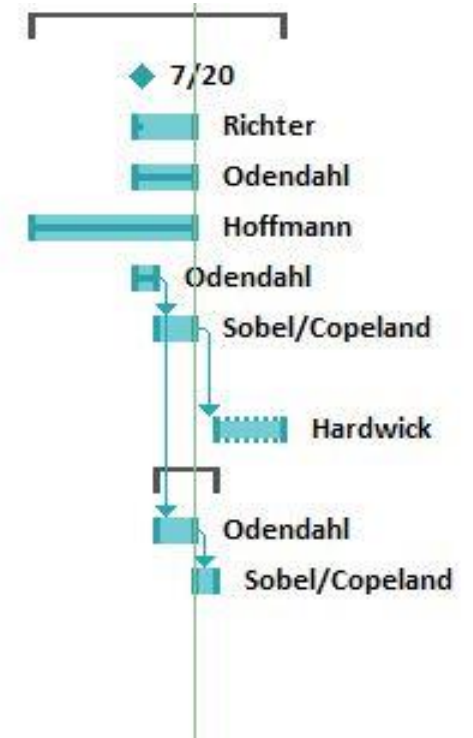
ENTITY executable
  [ ... other attributes omitted ... ]
  twin_source: OPTIONAL twin_source_enum;
  twin_plan: OPTIONAL executable;
  twinning_start : OPTIONAL Date_time;
  twinning_end : OPTIONAL Date_time;
  twinning_exception : OPTIONAL explanation;
END_ENTITY;

TYPE twin_state_enum = ENUMERATION OF (simulated, machined); END_TYPE;
  
```

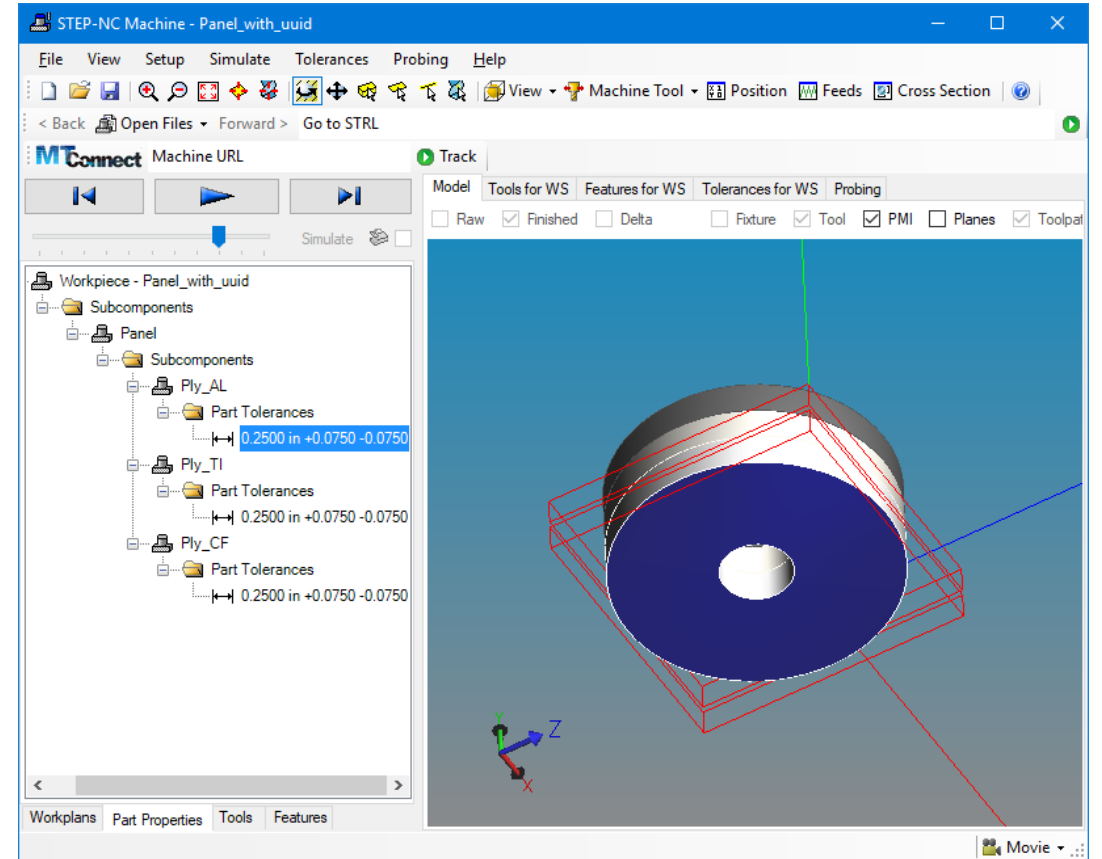
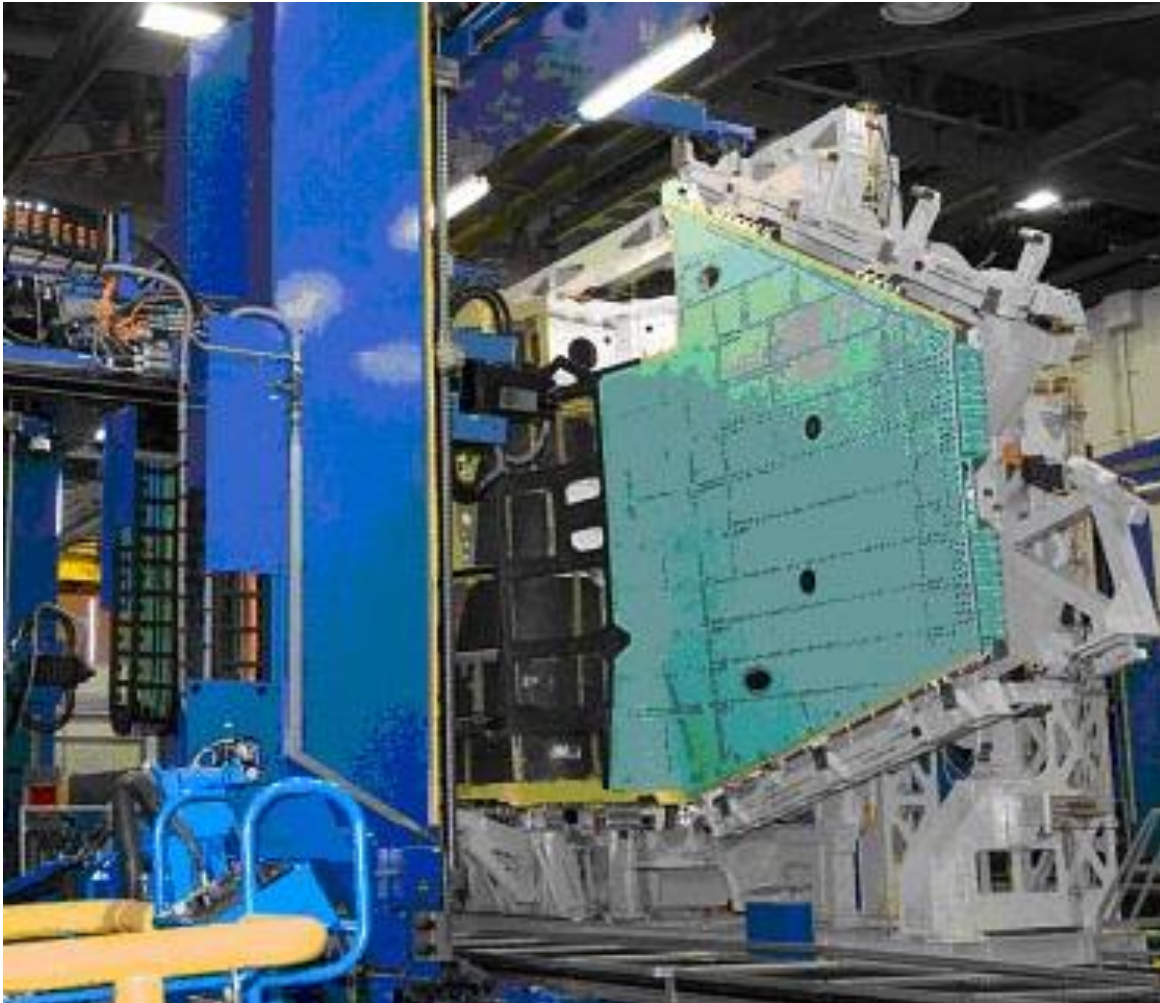
*Executable is supertype of all processes.
 Definition above shows new attributes for Edition 2*

Schedule

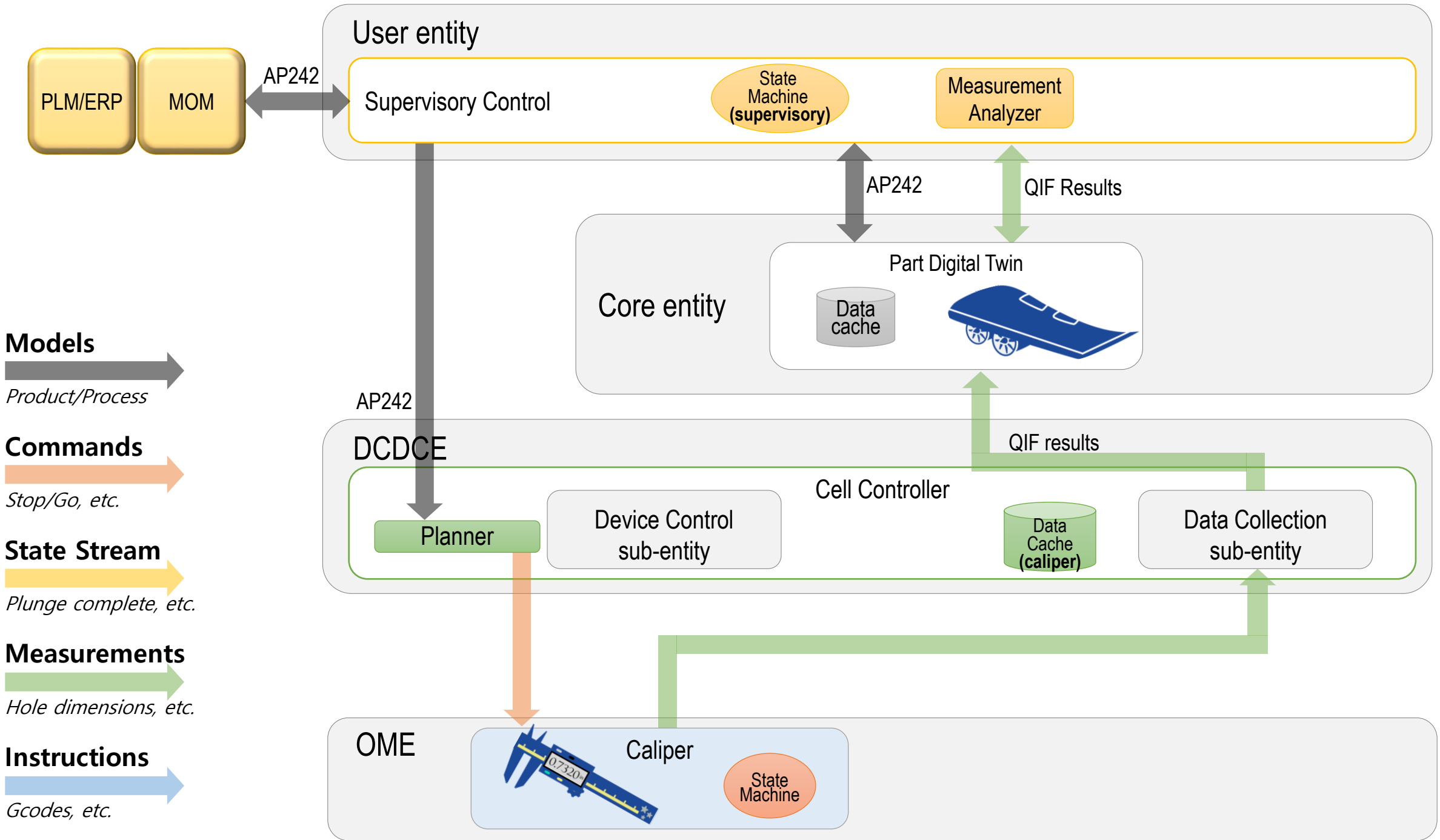
▾ CAD /CAM	25 days	Mon 7/6/20	Sat 8/8/20	
CATIA V5 -> AP238	0 days	Mon 7/20/20	Mon 7/20/20	
Supervisory Control	6 days	Mon 7/20/20	Mon 7/27/20	
AP238 -> Rapid	6 days	Mon 7/20/20	Mon 7/27/20	
Setup OPC/UA Server	16 days	Mon 7/6/20	Mon 7/27/20	
Define OPC/UA Tags	3 days	Mon 7/20/20	Wed 7/22/20	
Define MTConnect Tags	3 days	Thu 7/23/20	Mon 7/27/20	30
Setup MTConnect Adapter/Agent				
MTConnect -> Digital Twin	7 days	Fri 7/31/20	Sat 8/8/20	31
▾ State Machine	6 days?	Thu 7/23/20	Thu 7/30/20	
Define OPC/UA Tags	3 days	Thu 7/23/20	Mon 7/27/20	30
Define MTConnect Tags	3 days	Tue 7/28/20	Thu 7/30/20	35
Map MTConnect to PackML				
PackML Client				



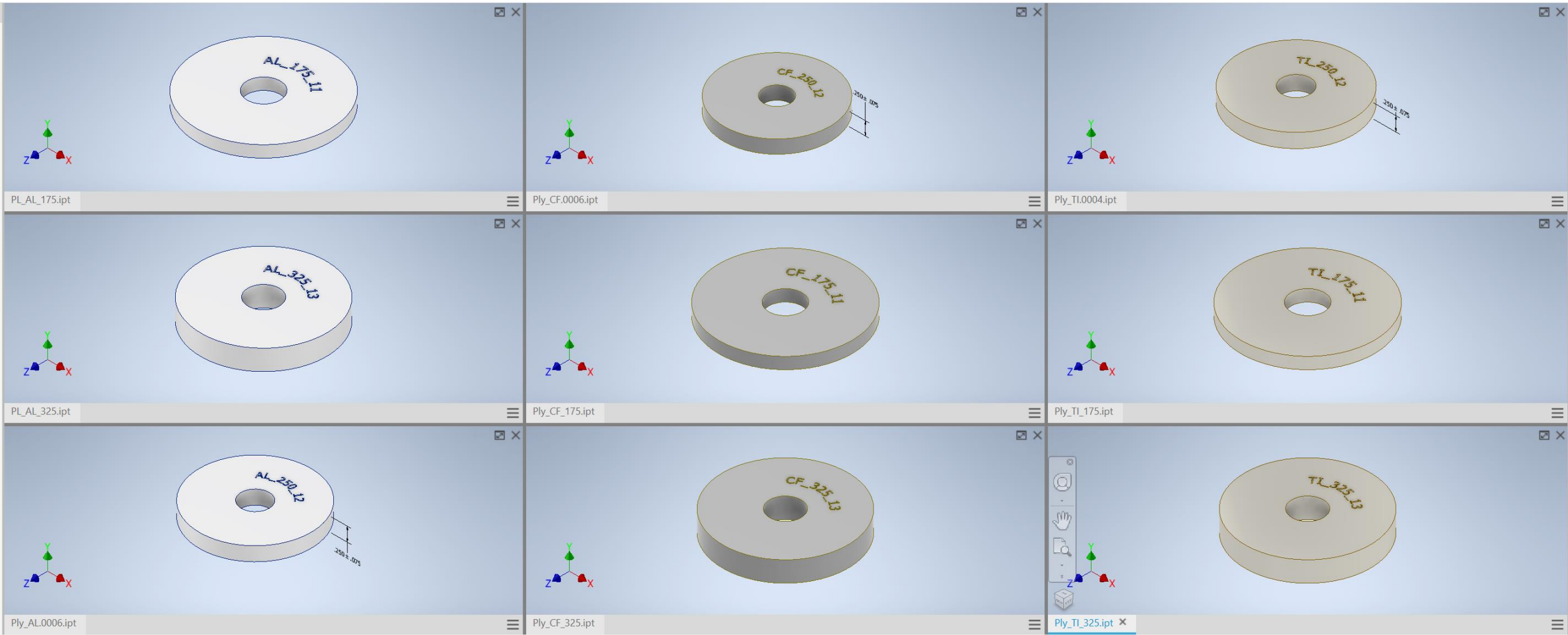
Use Case 2 – weight reduction



Exact match of fastener to hole depth
can reduce weight by 500lb

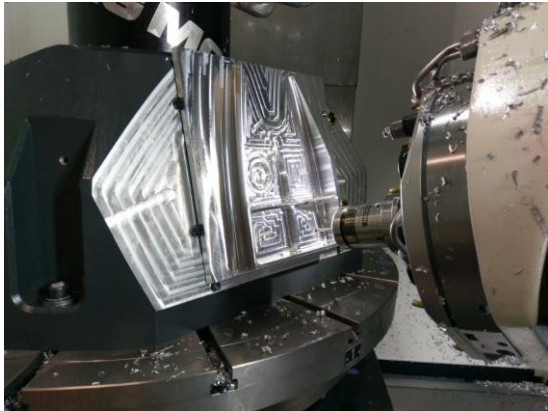


Measurement samples

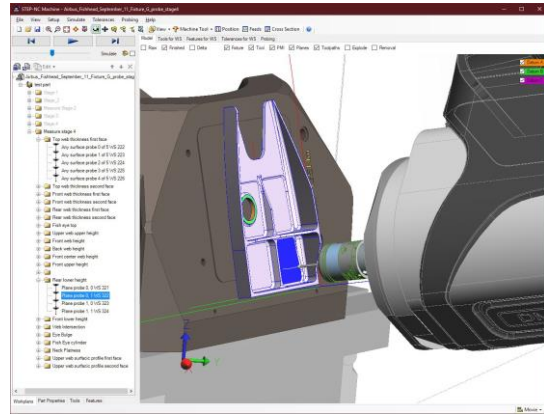


Task	23247 Use Case Reference	Completion Date	Completion %	Status
Define Use Case		16-Mar-20	100%	Complete
Document Use Case		22-Apr-20	100%	Complete
Author MBDs	PLM/ERP	14-May-20	100%	Complete
Export AP242 Nominals	User Entity	14-May-20	100%	Complete
Export QIF Plan	DCDCE	14-May-20	100%	Complete
Measure Parts (key-in)	OME	14-May-20	100%	Complete
Export QIF Measured Results	DCDCE	15-May-20	100%	Complete
Import QIF Measured Results	Core Entity	20-May-20	100%	Complete
Assemble AP242 Digital Twin	User Entity	20-May-20	100%	Complete
Revise Use Case	OME	30-Jun-20	100%	Complete
Receive Fabricated Parts		5-Aug-20		
Measure Parts (as-built)	OME	5-Aug-20		
Internal Rehearsal	OME	7-Aug-20		
Export QIF Measured Results	DCDCE	7-Aug-20		
Import QIF Measured Results	Core Entity	10-Aug-20		
Assemble AP242 Digital Twin	User Entity	14-Aug-20		
Evaluate As-built Digital Twin	PLM/ERP	28-Aug-20		Rehearsal

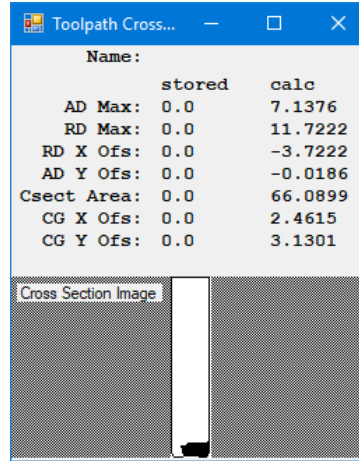
Use Case 3 – tool life optimization



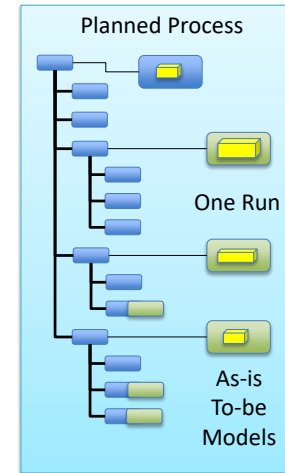
Machine parts



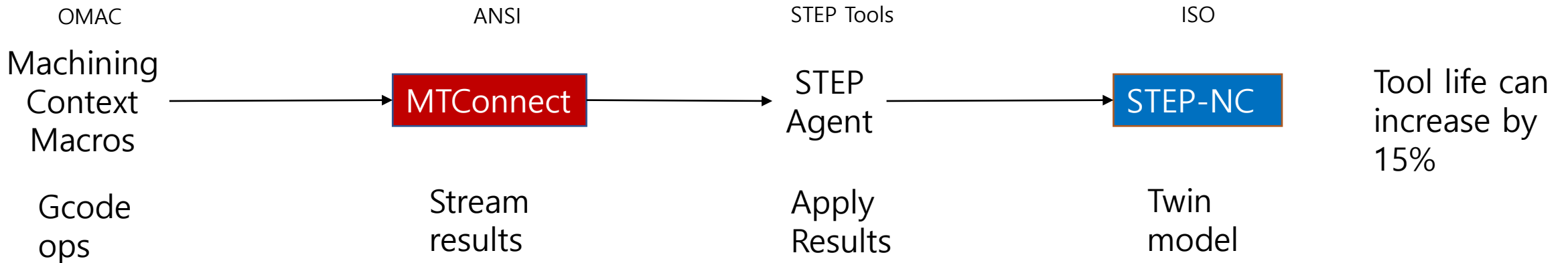
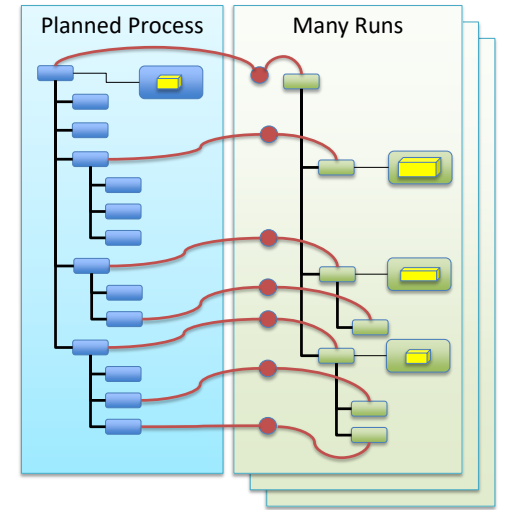
Monitor tool diameter



Compute tool engagement



Store linked data



ISO 23247-4 Figure A.3

